REMARKS/ARGUMENTS

Reconsideration is respectfully requested.

Claims 8-13 were pending before this amendment. By the present amendment, claims 1 is amended. No new matter has been added.

In the office action (page 2), claims 8-13 stand rejected under 35 U.S.C. §103(a) as being unpatentable over "Frequency Modulation Response of a Tunable Birefringent Mode Nematic Liquid Crystal Electrooptic Device Fabricated by Doping Nanoparticles of Pd Covered with Liquid-Crystal Molecules", Japan Journal of Applied Physics, vol. 41 (hereinafter "Yoshikawa") in view of U.S. Patent Nos. 4,701,024 (Kobayashi), 4,909,605 (Yoshino), and 4,836,654 (Fujimura).

More specifically, the examiner states that Fujimura allegedly teaches the following limitation as recited in claim 8:

> --wherein ... an electro-optical response is turned on by switching the frequency of applied electric field from low frequency to high frequency, and the electro-optical response is turned off by switching the frequency from high frequency to low frequency--.

However, the dual frequency driving as claimed in claims 8-13 of the present invention and the "dual frequency driving" taught in Fujimura are totally different as it will be fully explained below in detail.

In the presently claimed invention, the liquid crystal layer is a layer where the liquid crystal-soluble particles are dissolved or dispersed in the matrix liquid crystal. In other words, the liquid crystal layer comprises the matrix liquid crystal and the liquid crystal-soluble particles.

As disclosed in the specification page 8, line 27 to page 10, line 2, the

nanoparticle(s) of the present invention is/are the core of the liquid crystal-soluble particles and imparts frequency dependency to the electro-optical response. The frequency dependency is as follows.

The driving frequency is represented as "f", the dielectric relaxation time is represented as "f_R", and the frequency 10 times of the f_R is represented as "f_n". When the relation: $f > f_n$ is realized, a matrix liquid crystal with liquid crystal-soluble particles added exhibits the same dielectric anisotropy as a matrix liquid crystal with no liquid crystal-soluble particles added (addition-free case), and further, shows the similar electro-optical response as the latter case (addition-free case). Accordingly, when the relation: $f > f_n$ is realized, a threshold voltage where the matrix liquid crystal with liquid crystal-soluble particles added begins to respond (threshold voltage of the relation: $f > f_n$) is the same as a threshold voltage where the matrix liquid crystal without liquid crystal-soluble particles added begins to respond (threshold voltage of the addition-free case). The matrix liquid crystal with liquid crystal-soluble particles added turns on when an applied voltage is higher than the threshold voltage of the addition-free case, and turns off when an applied voltage is at threshold voltage of the addition-free case or lower.

On the other hand, when the relation: $f < f_n$ is realized, a degree of dielectric anisotropy of the matrix liquid crystal is decreased or lost. When a degree of dielectric anisotropy decreases, a threshold voltage increases. Accordingly, when the relation: $f < f_n$ is realized, a threshold voltage where a matrix liquid crystal with liquid crystal-soluble particles added begins to respond (threshold voltage of the relation: $f < f_n$) becomes

higher than a threshold voltage of addition-free case. Thus, when the relation: $f < f_n$ is realized, even if an applied voltage is higher than the threshold voltage of the addition-free case, the matrix liquid crystal with liquid crystal-soluble particles added turns off as long as the applied voltage is the same as/lower than the threshold voltage of the relation: $f < f_n$.

Therefore, when an applied voltage is kept constant, for example, as higher than the threshold voltage of the addition-free case to at/lower than the threshold voltage of the relation: $f < f_n$, the matrix liquid crystal with liquid crystal-soluble particles added turns on at the relation: $f > f_n$ and turns off at the relation: $f < f_n$. In other words, under a constant applied voltage, the electro-optical response is turned on by switching the frequency of applied electric field from low frequency to high frequency, and the electro-optical response is turned off by switching the frequency of applied electric field from high frequency to low frequency.

The dielectric relaxation time "f_R" is represented as below by the equivalent circuit analysis.

$$f_R = \frac{1}{2\pi\tau_1} \times \frac{1 + \frac{\sigma_2}{\sigma_1} \times \Phi_2^{1/3}}{1 - \left|\frac{\varepsilon_2}{\varepsilon_1}\right| \times \Phi_2^{1/3}}$$

In the above relation, the dielectric constant of a matrix liquid crystal is ε_1, the conductivity of the matrix liquid crystal is σ_1, the dielectric constant of a nanoparticle is ε_2, the conductivity of the nanoparticle is σ_2, the volume occupancy of the nanoparticle

is ϕ_2, and the dielectric relaxation time of the matrix liquid crystal (in case of a nematic liquid crystal) is τ_1.

In contrast thereto, the invention of Fujimura uses liquid crystal material having a crossover frequency at which its dielectric anisotropy becomes "0", and exhibiting a dielectric dispersion phenomenon wherein the polarity of the dielectric anisotropy is inverted from positive to negative in an electric field of a frequency lower than the crossover frequency and in an electric field of a frequency higher than the crossover frequency (claim 1). Further, the electro-optical response is turned on/off upon selective application of electric fields of two frequencies, i.e., high and low frequencies (column 4, lines 57-64).

Here, dielectric anisotropy of liquid crystals is explained. When a dielectric constant in a direction of liquid crystal director is represented as $\varepsilon_{\parallel}$, and a dielectric constant in a direction vertical to the director direction is represented as $\varepsilon_{\perp}$, the dielectric anisotropy is regarded as positive when the relation: $\varepsilon_{\parallel} > \varepsilon_{\perp}$ is realized, and the dielectric anisotropy is regarded as negative when the relation: $\varepsilon_{\parallel} < \varepsilon_{\perp}$ is realized.

Among the liquid crystal materials, there are materials which change their dielectric constant depending on the frequency of applied voltages and invert their dielectric anisotropy at specific frequencies. This change in dielectric anisotropy caused by the change in frequencies means that the alignment direction of the liquid crystal formed by an electric field is changed by the frequencies of the electric field. Such phenomenon is called dual frequency driving.

What Fujimura discloses is this dual frequency driving. The invention of Fujimura utilizes the feature that the dielectric anisotropy changes between positive and negative

depending on frequencies, and thereby imparts frequency dependency to the electro-optical response.

As explained, the present invention and Fujimura are common in the aspect that their electro-optical responses are turned on/off by changing the frequencies, but their respective mechanisms where the frequency dependency is seen in electro-optical response is totally different.

Unlike Fujimura, the present invention does not utilize the inversion phenomenon between positive and negative of dielectric anisotropy caused by the change in frequencies.

For the reasons above, the applicants respectfully submit that every limitation of claim 8 is **not** taught or suggested by Yoshikawa, Kobayashi, Yoshino, and Fujimura, whether or not these references are considered individually or in combination.

Further, the applicants respectfully submit that the dependent claims 9-13 are also considered allowable at least since they depend from claim 8, which is considered to be in condition for allowance for the reasons above.

For the reasons set forth above, the applicants respectfully submit that claims 8-13 pending in this application are in condition for allowance over the cited references. Accordingly, the applicants respectfully request reconsideration and withdrawal of the outstanding rejections and earnestly solicit an indication of allowable subject matter.

This amendment is considered to be responsive to all points raised in the office action. Should the examiner have any remaining questions or concerns, the examiner

is encouraged to contact the undersigned attorney by telephone to expeditiously resolve such concerns.

Respectfully submitted,

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